NUREG/CR-4884
BNL-NUREG-52063

Interpretation of Bioassay Measurements

Manuscript Completed: June 1987
Date Published: July 1987

Prepared by
Edward T. Lessard, Brookhaven National Laboratory, Upton, New York
Xia Yihua, Institute of Atomic Energy, Beijing, People's Republic of China
Kenneth W. Skrable, University of Lowell, Lowell, Massachusetts
George E. Chabot, University of Lowell, Lowell, Massachusetts
Clayton S. French, University of Lowell, Lowell, Massachusetts
Thomas R. Labone, University of Lowell, Lowell, Massachusetts
John R. Johnson, Chalk River Nuclear Laboratory, Ontario, Canada
Darrell R. Fisher, Battelle Pacific Northwest Laboratory, Richland, Washington
Richard Belanger, Science Applications International Corporation, San Diego, California
Joyce Landmann Lipsztein, Commissao Nacional de Energia Nuclear, Sao Paulo, Brazil

NRC Project Managers - B.G. Brooks and A. Brodsky

Prepared for
Division of Regulatory Applications
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, DC 20555
NRC FIN A-3289

Available from
Superintendent of Documents
U.S. Government Printing Office
P.O. Box 37082
Washington, DC 20013-7982
and
National Technical Information Service
Springfield, Virginia 22161

ABSTRACT

This is a comprehensive manual describing how to compute intakes from both in-vivo and in-vitro bioassay measurements. To date, interpretations of intake have been inconsistent, particularly in the early phases after an accidental intake. This manual is aimed at completely describing a consistent approach and instructing others on how to compute intakes and committed organ dose equivalents. Tables for the interpretation of bioassay results are compiled for several hundred radionuclides. Measurements which employ a whole-body counter, a thyroid counter, a lung counter, or measurements on excreta can be converted into estimates of intake based on the tables presented in the appendices. The values in the tables were determined by using lung, gastrointestinal tract and systemic retention models published by the International Commission on Radiological Protection (ICRP79). In a few cases, pseudo-retention functions, organ retention functions, and excretion functions were used to generate the tabulated values. The biological and radiological input parameters are included in an appendix, and a description of the mathematical approach that was used to derive the tabulated data is included in the methods section. Calculations for various particle sizes are addressed along with methods to interpret multiple or continuous exposures. Examples of use are based on actual bioassay measurements following accidental intakes, including tritium, Mn-54, Co-60, Sr-90, Nb-95, radioiodines, Cs-137, Ce-141, Ce-144, U-233, U-Nat, and Am-241.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

Page

PREFACE

The purpose of this report is to provide a practical and consistent method for estimating intakes from bioassay measurements, and to provide guidance in order to establish an effective internal radiation protection program. Our procedure for estimating intakes provides a way to rapidly assess the significance of an exposure. Users of this document will be able to demonstrate compliance with the provisions of 10CFR Part 20, and be able to assure adequate interpretation of bioassay measurements. Additionally this report may be useful in order to (1) establish derived investigation levels in the body or in excreta of exposed persons, (2) determine the frequency of monitoring individuals, and (3) determine the appropriate method of monitoring. Users of this document will be able to adjust their estimate of intake for particle sizes between 0.2 and 10 micrometers, and be able to interpret measurements associated with single, multiple or continuous intakes. Use of this report may also lead to further refinement of models which are used to interpret bioassay measurements.

ACKNOWLEDGMENT

The authors would like to thank Mr. Robert E. Alexander, Office of Nuclear Regulatory Research, United States Nuclear Regulatory Commission, for having the vision and initiative to appreciate the need for this work, to obtain the funds for it, and to recommend a group to work on the project.

We wish to express our sincere appreciation for the scientific review and sound advice from Dr. Allen Brodsky, Program Manager, Radiation Risk Management, Nuclear Regulatory Commission, and from Dr. John Baum, Associate Head for Research, Safety and Environmental Protection Division, Brookhaven National Laboratory. Additionally, we wish to thank Barbara Brooks, Program Manager, Office of Nuclear Regulatory Research, Nuclear Regulatory Commission, for helping to bring this program to completion.

We wish to acknowledge the contributions of the following persons and thank them for a job well done. They are: E.P. Hope, C.L. Clary, and B.E. Kirstein, Science Applications International Corporation; we thank them for modifying and applying the REMedy and DOSEDAY/DOSEYR programs for use in the validation effort. We also thank Marie Cooney, Brookhaven National Laboratory for typing the manuscript, and Cheryll Christie for assisting in this work.